Some Reflections on the Quantum World

We continue the proceedings with discussion of a topic in which Sir Karl Popper has always taken a keen interest, viz. the interpretation of QM.
Our two speakers this morning have been in the very forefront of research and discussion in the philosophy of QM during the past 15 years or more and it gives me particular pleasure to introduce Professor Abner Shimony, who holds appointments in both the physics and philosophy departments at Boston University and Professor Arthur Fine of the University of Illinois at Chicago Circle.
First of all then Professor Shimony will give us a paper entitled
"Some Reflections on the Quantum World"
– Professor Shimony

Thank you very much. I will now call on Professor Fine to reply

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Well there we have a very interesting contrast of views: Both Shimony & Fine are I take it realists and objectivists – they take QM to be a theory about the world rather than just our knowledge of the world. In this sense they are sympathetic to Popper's views on QM, but at a more detailed level Fine's views are closer to

Popper's then Shimony's. Fine, Popper see a world of perceived values rather than a world of potentialities. Propensity for Shimony is not just an objective interpretation of probability theory appropriate to QM, but ontologically is all there is in certain states. Why? I ask Shimony his comments on Fine's attempt to retain classical-style of realism of measured values.

and what is Fine's view of a realism about propensities and dispositions. What is it he does not like about this realism? Is it more than a prejudice in favour of classical-style physics?

Other Questions

1. Stapp - Eberhard - Peres formulation of Bell theorem in terms of outcomes of macroscopic apparatus - no reference to underlying microstates.
Principle of counterfactual definiteness
If I measure ~~not~~ the outcome along a setting a, then the measured value it would have had along a' have a definite value.
Locality in this formulation is not a reasonable requirement in an indeterministic world.
Comment on Eberhard's non-counterfactual formulation.

The Great Quantum Muddle is to confuse a probability distribution or propensity with a property of the individual systems or particles — It is a property of repeatable experimental arrangement

2.) EPR argument for $\frac{1}{\sqrt{2}}(\alpha(1)\beta(2)+\alpha(2)\beta(1))$ still goes through – eigenvalue of $\sigma_1 \cdot \sigma_2$ which does does not commute with σ_{z2}.

3.) Does superluminal connection contradict relativity? Causal loop paradox of Redhead. Pirani, [illegible] are not explained by [illegible] [illegible] [illegible], Sudarshan. Transposition of [illegible] on [illegible] may not be correct if notion of probability of [illegible] is called in question

4.) Status of Stat. Fore. of Fore. standard? ~~Prob $[f(\theta)]_D$ = Prob~~

$$\text{Prob}\,[D]_{f(\theta)} = \text{Prob}\,[f^{-1}(D)]_{\theta}.$$

5.) Projection operators $\langle P \rangle \neq 0$ in state for which value of P is unassigned?

6.) Kibble on Non-linear QFT
– generalization of Bialynicki-Birula & Mycielski work

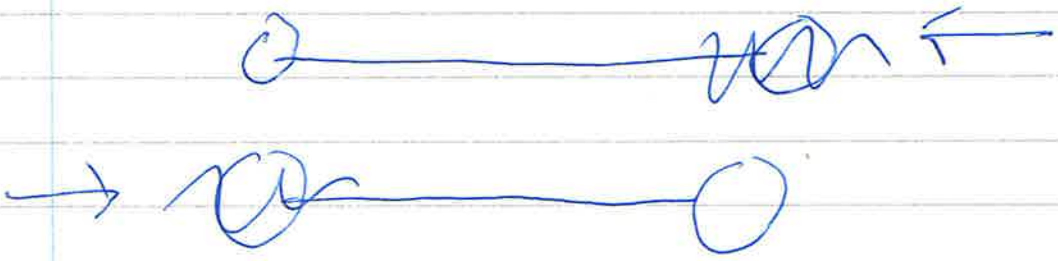
7.) The Great Quantum Muddle.
– selective versus non-selective measurement.

8.) Relational aspects of reality as reflected in propositions. Particle B behaves as if it had definite σ_z for observables $1 \otimes B$, not for $\sigma_{xA} \otimes \sigma_{zB}$ e.g.

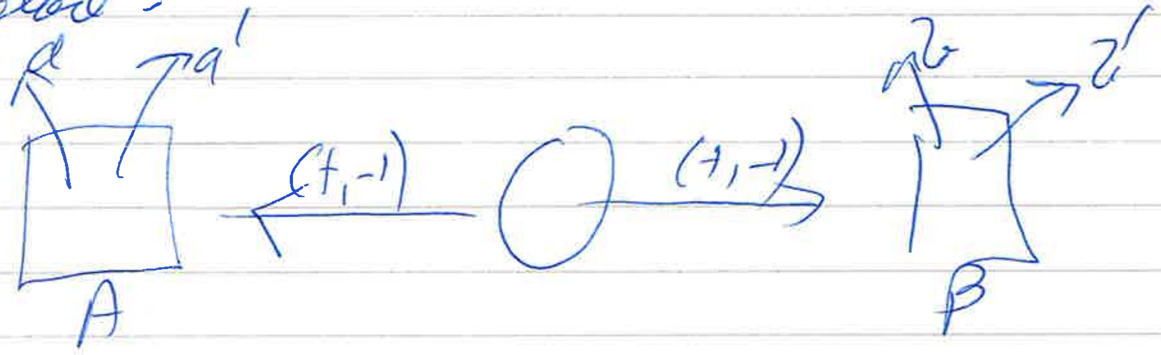
i.e. relational (or conditional) properties are fuzzy

and

not



this is holism properties of entangled QM state cannot be understood in terms of reduced states of component particles Components behave like a so-called unified medium -



Four experiments — a b
a b'
— a' b,
a' b'

9.) Relation of Shimony to later ideas of Margenau (McKnight) and Whitehead ontology supported by Stapp.

10.) Stairs' proof of [illegible] using 2 coupled Spin 1 systems.

11.) attitude to Bohr. Finality of the tranquilising Bohr philosophy prevents us from conjecturing about reality — it therefore puts a brake on future theories and is in this sense a thoroughly anti-Popperian approach to scientific theories. Bohr sees us cut off from reality by insurmountable epistemological barriers. but does Bohr have an ontological as well as an instrumental interpretation (cf Stapp)?

Final Remarks

3 views on QM.

1) Bohr QM mysterious – we have to use classical concepts but with suitable restrictions imposed via the principle of complementarity. Important epistemological discovery (limitations of knowledge and loss (?) of definability)

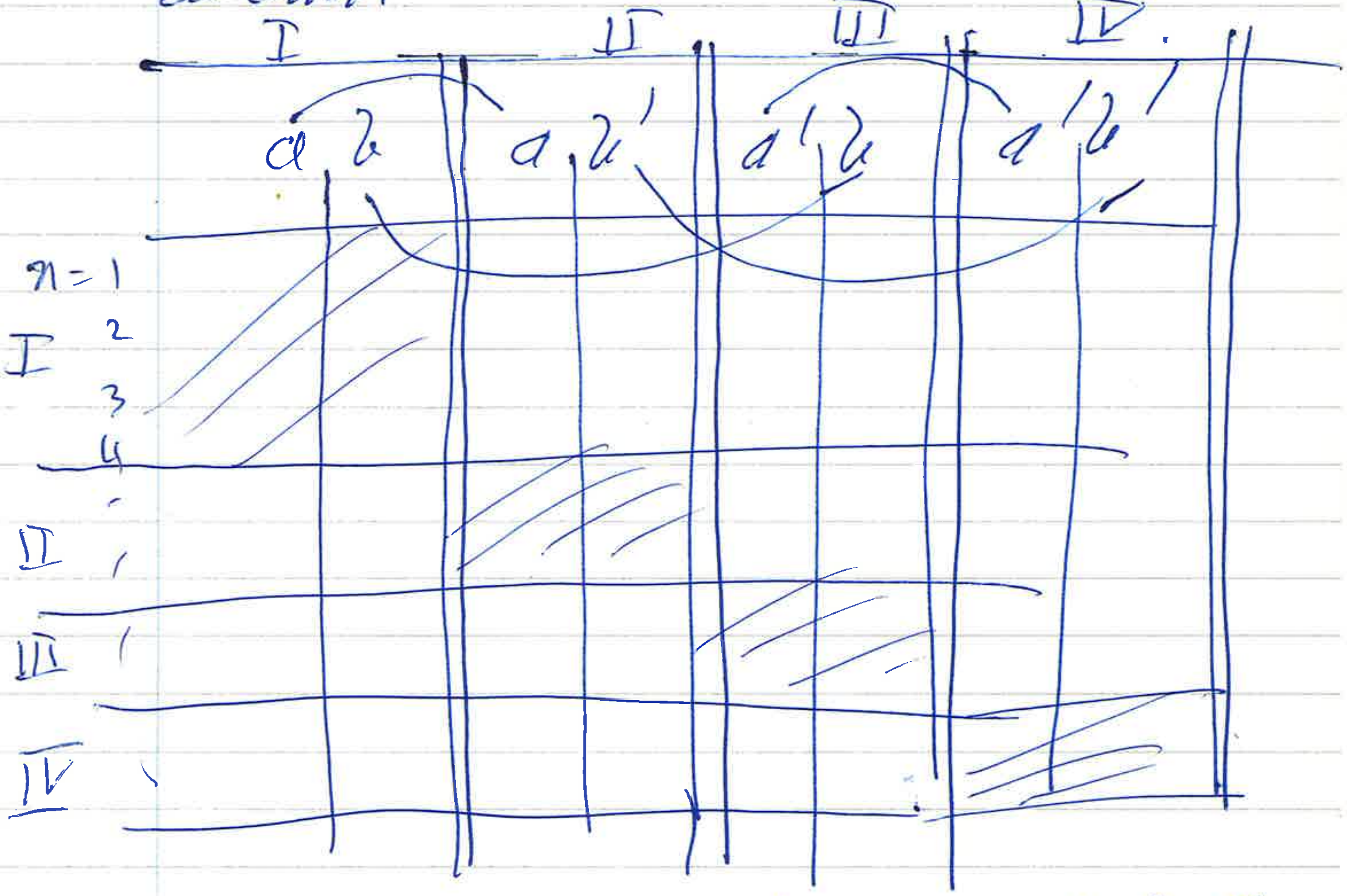
2.) QM is mysterious requires new concepts such as potentiality or non-standard logics

3.) QM is not mysterious – a particle is a particle is a particle – QM is a sophisticated statistical mechanics with inherent objective indeterminism built in to it. This last is Popper's view in a nut shell, and is supported by Fine. However it does look as if the concepts of classical physics can only be used with some degree of artificiality and of looseness to describe the micro-world. Perhaps we should have the courage to let the physics guide us towards new and more [illegible] sophisticated brands of realism.

I shall not attempt to sum up. Our two speakers have advanced their contrasting points of view with admirable clarity. I am sure you would all like to join with me in thanking them very much for their very stimulating and interesting papers.

experiments simultaneously on each particle pair, i.e. each value of n.

However we can partition the N total values of measured values into 4 sets on each of which we can perform one of the 4 correlation measurements. This involves a place-selection on the sequence of a, b values e.g. but this can be only compatible place-selection and is not dictated by the results of individual trials so it is quite innocuous is not altering the limiting frequencies computed on all the entries in the a b column.



~~Now but notice we have assumed locality~~ 2
~~in the sense that the value of b is the~~
~~same in I & III in a given row~~

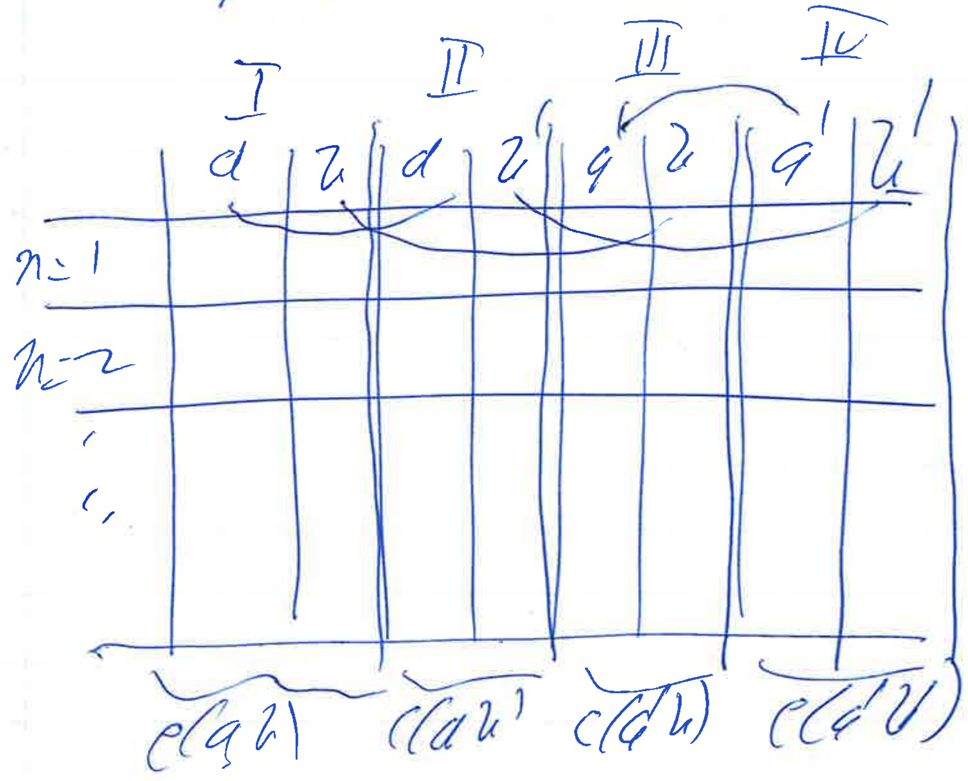
Four Senses of Locality

sharp value → sharp value, 'at a distance' **Locality$_1$**: A sharp value cannot be changed into another sharp value at a distance.

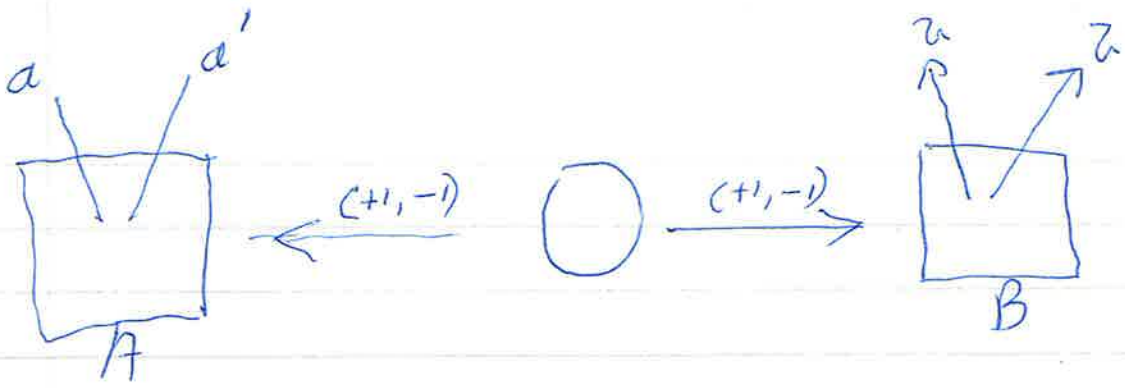
macroscopic version **Locality$_2$** A macroscopic object cannot have its classical state changed at a distance.

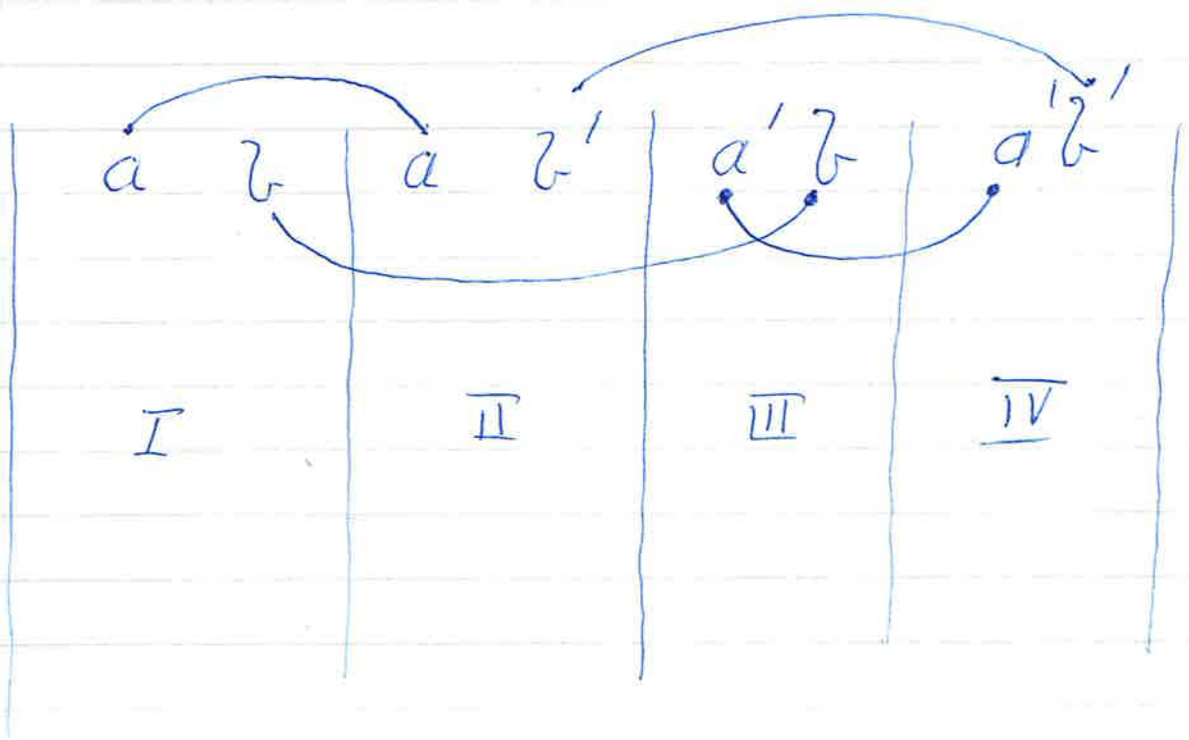
unsharp value → sharp value ~~at a dist~~ **Locality$_3$** An unsharp value cannot be turned into a sharp value at a distance

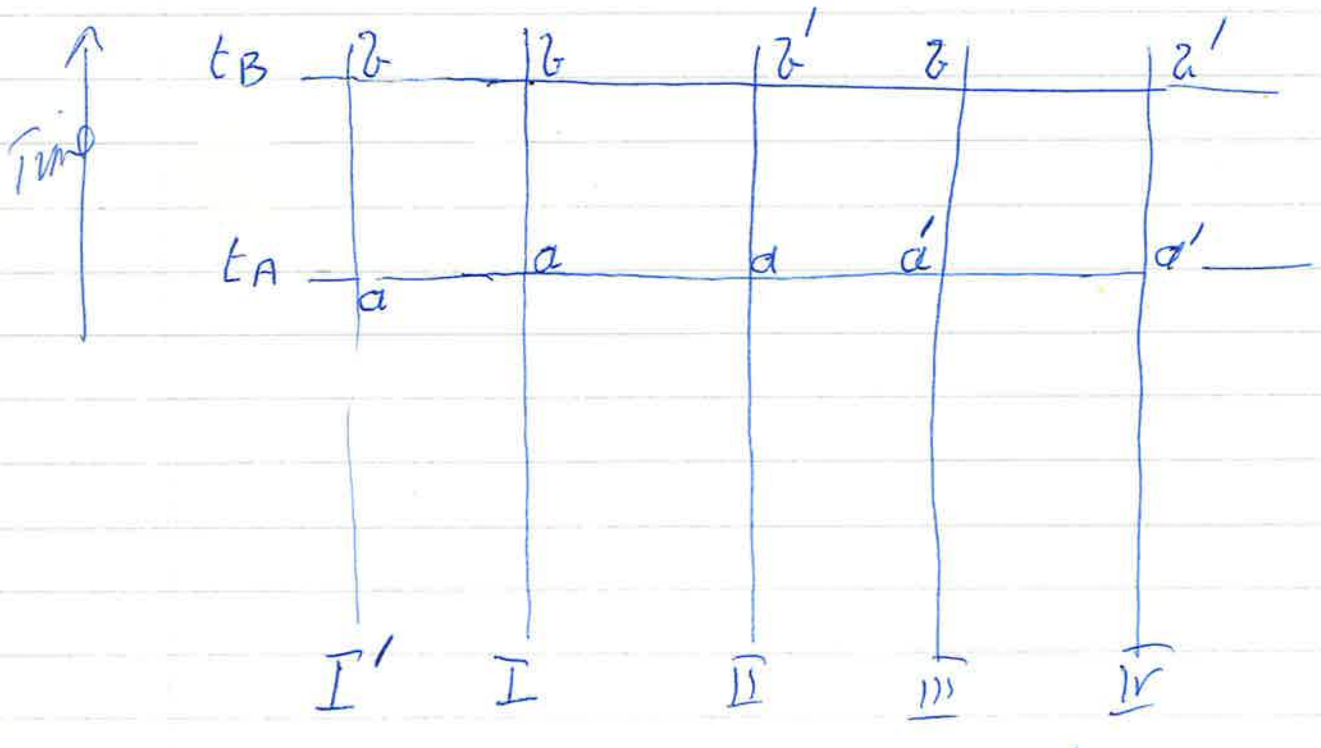
undefined value → defined value **Locality$_4$** An undefined value cannot be ~~made~~ defined by measurements performed at a distance.



Locality$_5$: Statistics of measurement results cannot be changed 'at a distance'.


a
a'
A
(+1, −1)
(+1, −1)
b
b'
B


a
b
a
b'
a'
b
a'
b'
I
II
III
IV


Time
t_B
t_A
b
b
b'
b
b'
a
a
a
a'
a'
I'
I
II
III
IV

$$\gamma_{\dot n} = a_{\dot n} b_{\bar n} + a_{\dot n} b'_{n} + a'b - a'b'$$